Spectrum Efficiency Research and Engineering

Outputs

- Report on Federal LMR systems in Washington, DC, area.
- Internal papers on spectrum efficiency concepts.
- Consultation with OSM on spectrum efficiency planning.

NTIA is deeply committed to an extensive multi-pronged program to improve the spectrum efficiency of Federal radio systems. This program was given additional importance by the May 2003 announcement of a November 30 Presidential Spectrum Policy Initiative to promote the development and implementation of a U.S. spectrum management policy for the 21st century. More recently, NTIA administrator Michael Gallagher announced a multi-year effort to carry out a series of spectrum efficiency directives contained in a November 2004 Presidential Memorandum to multiple Federal departments. Although most of this work will be accomplished by NTIA/OSM in Washington, ITS is also playing a key role in several aspects of the work.

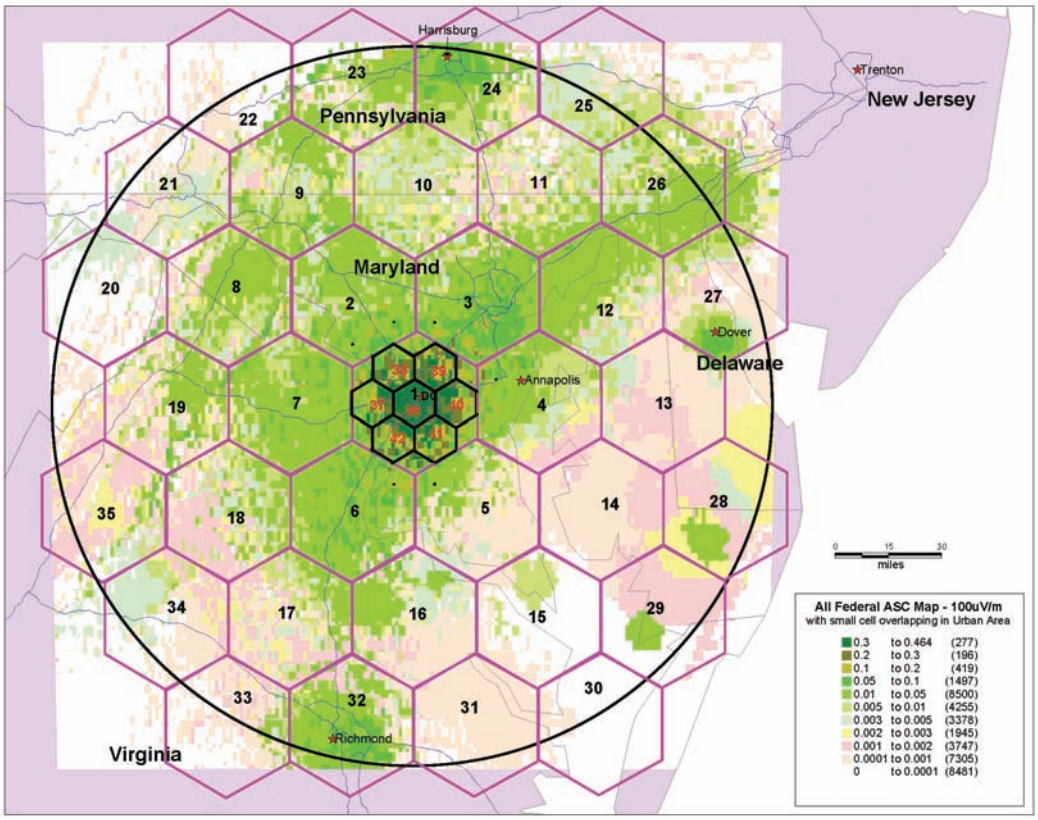
ITS is working with OSM to develop theoretical concepts and practical applications of improved spectrum efficiency. One problem is that "spectrum efficiency" can mean many things — some of them contradictory — and ITS has been active in helping to sort out concepts that will be useful in guiding Federal policies toward more effective use of the radio spectrum. An internal NTIA paper on spectrum efficiency concepts was written to guide discussion on some of the problematic aspects of spectrum efficiency that needed to be resolved to help NTIA develop improved policies and practices.

ITS is currently examining possible categories of definitions (sometimes equations) that describe the spectrum efficiency and effectiveness of several types of radio services. Initial work suggests that there is considerable flexibility in the choice of definitions; the choice will need to match the specific purposes for which the calculations will be performed. These definitions typically differ in the factors selected to represent significant features of the real world. Sometimes it is sufficient to consider only the technical characteristics of the radio equipment; sometimes it is necessary to consider how the equipment characteristics match the operational requirements of the mission. The computation methodologies and the numeric answers for a specific situation can differ considerably, depending on the nature of the definition that is selected.

ITS has been assisting OSM in a modeling effort to see whether the current myriad of single-agency Federal mobile radio systems in the Washington, DC, area could be efficiently replaced by one large shared trunked radio system. The first part of this work was completed in FY 2004, including a draft report "Phase 1 - Study of Federal operations in the 162-174 MHz band in the Washington, DC, area," which is now awaiting final clearance for publication. This work investigated the current Federal land mobile radio (LMR) systems within 100 miles of Washington, DC. This study developed a signal capacity (SC) model that uses Government Master File (GMF) Federal radio license data and terrain-based propagation models to provide a combined geographical coverage "footprint" of the multiple independent existing radio systems now serving Federal Agencies. This model showed that as many as 268 separate LMR radio channels were available to a mobile user in the downtown Washington area in the 162-174 MHz band, as well as summarizing the geographical coverage of current systems.

Another input to a model for the design of future LMR systems was the measurement of actual LMR traffic (Erlangs) in the Washington area, using the ITS Radio Spectrum Measurement Science (RSMS) system, as described on pp. 6-9 of this report. These measurements were completed in early 2005, and the results have been used to describe the total amount of traffic that a possible future shared radio system should be designed to handle. A report on the RSMS measurements should be published soon.

The design of possible future alternative shared LMR systems will be based on the signal capacity geographical coverage data and the RSMS measured traffic data. The figure shows the Average Signal Capacity (ASC) map for Washington, DC, overlaid with a 100-mi radius circle, and idealized hexagonal coverage areas for one of the proposed future



Possible future alternative shared LMR system using large cells overlapped with small urban cells.

systems. The ASC map shows the number of independent radio systems per square mile (actual ASC values are multiplied by 10,000 on the map). This ASC data is summed over the coverage area and multiplied by measured channel occupancy data to get the nominal traffic load in Erlangs that each cell must support. This example uses rural/suburban cells with a 20-mile coverage radius (violet hexagons) overlaid with 7-mile radius cells in the densest urban areas (small black hexagons). Several different architectures have been evaluated using various assumptions about the total number of users participating in the shared system, including traffic loads as large as ten times more than current traffic loads. A report on the completed evaluation will compare the expected costs and number of frequencies needed for the alternative future systems and the current LMR systems.

Recent Publications

J.R. Hoffman and R.J. Matheson, "RSMS measurement and analysis of LMR channel usage," in "Proceedings of the 2005 International Symposium on Advanced Radio Technologies: March 1-3, 2005," J.W. Allen and J. Ratzloff (Eds.), NTIA Special Publication SP-05-418, Mar. 2005.

R.J. Matheson, "Flexible-use spectrum rights". in "Proceedings of the 2005 International Symposium on Advanced Radio Technologies: March 1-3, 2005," J.W. Allen and J. Ratzloff (Eds.), NTIA Special Publication SP-05-418, Mar. 2005.

G. Patrick, et al., "Phase 1: Study of Federal operations in the 162-174 MHz band in the Washington, DC, area," NTIA Report in progress.

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